The Impact of A2L Refrigerants in Multifamily Construction:

Navigating the 2024 I-Codes for Safe and Effective Design[1., 2.]

By: Wanda D. Edwards, PE, Wanda Edwards Consulting

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INTRODUCTION

This white paper explores the implications of using A2L refrigerants in multifamily construction, offering guidance to architects, engineers, and local code officials. As states and jurisdictions lag in adopting updated 2024 I-Codes, it is crucial to understand the safety concerns and design challenges posed by these refrigerants.

Safety concerns with A2L refrigerants are a critical consideration for any project involving their use, particularly in multifamily construction. A2L refrigerants, such as R454B and R32, are categorized as mildly flammable, and while they offer environmental benefits and improved energy efficiency, they also pose specific risks that must be carefully managed.

BACKGROUND

The United States Environmental Protection Agency (EPA) issued a final rule on October 5, 2023, to restrict the use of hydrofluorocarbon (HFC) refrigerants due to their environmental impact, particularly their high global warming potential (GWP). Initially, refrigerants such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) were introduced for use in home air conditioning. In 1987 the United States signed the international treaty called the Montreal Protocol on Substances that Deplete the Ozone Layer which led to the phase out of class 1 substances such as CFC's in 1996 and class 2 substances such as HCFC's in 2010. Hydrofluorocarbons (HFCs) were then introduced as an alternative refrigerant to these ozone depleting substances.[3.] However, HFC's are potent greenhouse gases with high levels of global warming potential that have a negative impact on climate. This has led to the phaseout of these substances starting in 2025 to favor newer options like A2L refrigerants, which have lower GWP but present challenges such as mild flammability, requiring careful management and updated safety standards.

A2L refrigerants, characterized by low flammability and low toxicity, are being adopted as environmentally friendly alternatives in air conditioning and refrigeration systems. The "A" designation signifies low toxicity, while "2L" indicates mild flammability with a slower flame propagation speed compared to other flammable refrigerants. However, the construction industry faces significant challenges in transitioning to A2L refrigerants, particularly in regions where local codes have not yet been updated to reflect the latest safety standards. The 2024 International Codes (I-Codes) offer essential guidelines for safely integrating these refrigerants into multifamily buildings.

KEY SAFETY CONCERNS WITH A2L REFRIGERANTS

A2L refrigerants, while less flammable than Class 1A or 1B refrigerants, still present significant safety concerns due to their lower flammability limit (LFL), which makes them capable of igniting if sufficient concentrations accumulate in the presence of an ignition source. In confined or poorly ventilated spaces, leaks could lead to the buildup of flammable concentrations, increasing the risk of fire or explosion. Common ignition sources, such as electrical equipment, open flames, or static electricity, pose a threat if they are near HVAC systems using A2L refrigerants, necessitating careful design and construction to minimize these risks. Effective leak detection and mitigation systems are essential, particularly in multifamily buildings, to quickly address refrigerant releases and ensure proper ventilation to prevent

hazardous concentrations. Proper storage, as outlined in UL 60335-2-40 Annex GG, and strict handling procedures are critical to preventing accidental releases or exposure to ignition conditions. Given the multifamily context, occupant safety is paramount, requiring tailored emergency procedures, evacuation plans, and fire suppression systems to address the specific hazards associated with A2L refrigerants.

SIGNIFICANT CHANGES TO THE 2024 I-CODES REGARDING A2L REFRIGERANTS[5.]

The 2024 editions of the International Mechanical Code (IMC) and the International Residential Code (IRC) have been updated to include provisions for A2L refrigerants. These updates address proper ventilation, leak detection, and the use of non-sparking tools in areas where these refrigerants are handled. For multifamily buildings where refrigerant lines penetrate two or more fire-rated floor assemblies, the building code requires refrigerant lines to be placed in a fire-rated shaft or that other fire safety measures be implemented as specified in Section 1190.2.2. of the IMC.[4.]

INTERNATIONAL MECHANICAL CODE (IMC)

The 2024 International Mechanical Code introduces several significant updates regarding A2L refrigerants. Table 1103.1 now includes A2L refrigerants in its classification, and equipment using these refrigerants must comply with UL 484, UL/CSA 60335-2-40, or UL/CSA 60335-2-89. A2L refrigerants are recommended for air conditioning systems used for human comfort, with specific exceptions based on occupancy type and refrigerant quantity. Refrigerant piping must be protected either within building elements or by enclosures, though certain conditions permit exemption from enclosures. Refrigerant piping is prohibited in fire-rated exit access corridors, interior exit stairways, ramps, passageways, elevator shafts, and shafts with moving objects. Identification of refrigerant piping outside the equipment room must be clear and frequent, including specific warnings for A2L refrigerants. Testing of refrigerant systems must use inert gases such as oxygen-free nitrogen or helium, while prohibiting gases like oxygen, air, and combustible gases.

INTERNATIONAL RESIDENTIAL CODE (IRC)

According to the 2024 International Residential Code, refrigeration cooling equipment using A2L refrigerants must be listed and labeled under UL/CSA 60335-2-40. For such systems, compliance with the manufacturer's installation instructions is required, and all related documentation must be provided to the homeowner. Additionally, field-installed accessories in ductwork must adhere to manufacturer guidelines and avoid electric heating elements or devices with electrical loads exceeding 2.5 kVA. Refrigeration systems using A2L refrigerants must have a permanent, legible label with contact information and refrigerant details. The refrigerant charge must not exceed 34.5 pounds and should align with the manufacturer's specifications. Piping systems must be tested according to these instructions. Annex GG of UL 60335-2-40 outlines storage and mitigation measures for multifamily buildings to manage the risks associated with A2L refrigerants. One such safety measure is the three-level classification system based on refrigerant charge: m1, m2 and m3, based on the lower limit of flammability of the refrigerant. The lowest designation is m1 and the highest is m3. These designations determine the mitigation method that must be provided. Unitary air conditioning system with a charge less than m1 do not require any safety controls, whereas charges greater than m1 and up to m3 must have safety controls to respond to refrigerant leaks.

REFRIGERANT PIPE SHAFT REQUIREMENTS

Shafts containing A2L refrigerants must be provided with either natural or mechanical ventilation. Naturally ventilated shafts require a pipe with a minimum diameter of 4 inches, connecting the lowest point of the shaft and extend to the outdoors and should be level or sloped downward. Exhaust outlets must discharge to the outdoors following Section 501.3 of the 2024 IMC to prevent nuisance or hazard.

For shafts containing more than one system of A2, A3, B2 or B3 refrigerants, continuous mechanical ventilation is required, including the installation of a refrigerant detector. Mechanically ventilated shafts must meet the minimum airflow velocity as specified in Table 1109.3.2, Shaft Ventilation Velocity in the 2024 IMC. The table provides the required minimum velocity based upon the cross-sectional area of the shaft. The number of pipes in the shaft, and the cross-sectional area of the shaft will influence the number of pipes allowed in the shaft. For example, a mechanically ventilated shaft with a cross-sectional area less than or equal to 20 square inches would require a minimum ventilation velocity of 100 feet per minute. Calculations of the air velocity should be performed by a design professional. The mechanical ventilation systems are permitted to operate continuously or be triggered by a refrigerant detector, which must activate at 25 percent of the lower flammable limit. The detector is required to be installed where refrigerant concentration would be highest in the case of a refrigerant leak. Double walled pipes should have the interstitial space vented outdoors.

Refrigerant piping that penetrates two or more floor/ceiling assemblies and a fire-resistant shaft enclosure that complies with the Section 713 of the International Building Code (IBC) is required. The enclosure must have a fire-resistance rating of at least one hour for shafts connecting fewer than four stories and two hours for those connecting four or more stories.

The enclosure's fire-resistance rating should match the floor assembly it penetrates but should not exceed 2 hours. There are many factors that determine shaft requirements of the IBC, such as occupancy, building construction type, enclosure at the top and bottom of the shaft and fire separation distance, separation from the adjoining building. Refrigerant piping is not required to be enclosed when located within 6 feet of the refrigeration unit. A design professional should be consulted to determine specific requirements for the shaft enclosure. For systems where refrigerant piping does not penetrate multiple floors, a fire-resistant shaft enclosure is not required.

VARIATIONS IN BUILDING CODE ADOPTIONS ACROSS THE UNITED STATES

Building codes in the United States are essential for ensuring safety, sustainability, and efficiency in construction. These codes are developed by organizations like the International Code Council (ICC), which publishes the International Codes (I-Codes) that many states and local jurisdictions use as the basis for their regulations. However, the adoption and implementation of these codes vary significantly across the country due to regional needs and priorities. States in hurricane-prone areas, for example, may have stricter wind resistance requirements, while those in seismic zones emphasize earthquake-resistant construction. This flexibility allows for customization but also creates challenges in maintaining uniform safety and efficiency standards nationwide.

CONCLUSION

Given the diverse regulatory landscape, it is crucial for architects, engineers, and code officials to proactively engage with local authorities. They should verify whether local regulations permit the use of certain materials or methods, such as A2L refrigerants, and explore alternate design methods if necessary. Early communication with the local Authority Having Jurisdiction (AHJ) can help ensure compliance with both safety standards and local codes. As climate risks increase, the ICC and other stakeholders are advocating for the adoption of the latest codes, though achieving uniformity remains complex due to the diverse needs across the U.S.

RESOURCES

For more information and training on A2L refrigerants, visit:

- International Code Council (ICC)
- Air Conditioning, Heating, and Refrigeration Institute (AHRI)
- Mechanical Contractors Association of America (MCAA)
- American Society of Heating, Air Conditioning and Refrigeration Engineers (ASHRAE)
- Air Conditioning Contractors of America (ACCA)
- The International Code Council provides the documents containing the needed revisions for older editions of the I-codes to comply with A2L requirements at: (https://www.iccsafe.org/products-and-services/i-codes/a2l-refrigerants-transition/)
- AHRI provides an interactive map showing the status of A2L adoption in each state (https://www.iccsafe.org/products-and-services/i-codes/a2l-refrigerants-transition/)

REFERENCES

1. The 2024 edition of the International Mechanical Code and International Residential Code

2. Code Changes on A2L Refrigerants, Cika and Lukasik, January 2022, International Code Council

3.FAQ's on the Phase Down of Hydrofluorocarbons, EPA, Reducing HFC's

4. National Association of Home Builders blog, https://www.nahb.org/blog/2024/05/new-refrigerants-hvac, May 2024.

5. 2024 I-Code A2L Refrigerant Related Changes, First Printing August 23, 2022, International Code Council